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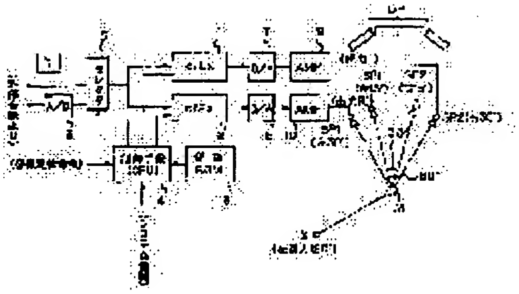
(54) SOUND IMAGE LOCALIZATION CONTROLLER

(57)Abstract:

PURPOSE: To provide a sound image localization controller in which a listener M (operator) senses as if a sound image localized at an optional desired position in the sound field reproduction of a game machine or the like.

CONSTITUTION: The sound image controller is formed by a couple of convolvers 1, 2 applying convolution arithmetic operation processing to a signal from a same sound source (X), a storage means 3 retaining a coefficient group (impulse response) for cancel filtering use at each sound image localized position, and a



coefficient supply means 4 supplying a coefficient corresponding to the designated sound image localized position to the convolvers. Then a signal subjected to convolution arithmetic operation processing by the convolvers 1, 2 is reproduced by a couple of speakers sp1, sp2. Thus, a listener (M) senses as if the sound image were localized at an optional position (x) by varying the coefficient set to the convolvers 1, 2.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the image static-control equipment impressed with the image orientating in the location of the arbitration of a different request from an actual transducer (loudspeaker), it excels in the feeling of the image normal position which can be especially carried in an amusement game machine, a computer terminal machine, etc., and a circuit scale is related with small image static-control equipment.
[0002]
[Description of the Prior Art] Before, there is the image normal position method of giving a sound source in a specific location (the specific direction) according to the level difference and phase contrast (time difference) of a signal in both ears. "The image formation method and its equipment" given [for example,] in JP,2-298200,A are one of those realized this image normal position method by the digital circuit. The image stereotaxic instrument using this digital circuit carries out FFT (Fast Fourier Transform) conversion of the signal from a sound source, processes it on a frequency shaft, gives the level difference and phase contrast depending on frequency to both channel signals on either side, and controls the normal position of an image in digital one. The level differences and phase contrast depending on frequency in each image normal position location of this equipment are collected as experimental data using an actual listener. However, since the circuit scale became large by this image stereotaxic instrument when it was going to make exact and a precision orientate an image, it was used as a special business-use recording system. The image normal position was processed in the phase of recording (for example, migration of a flight sound), and the sound (music) signal of the processed result was record-ized. The migration effect of an image produces the processed signal by reproducing with usual stereophonic reproduction equipment.
[0003]
[Problem(s) to be Solved by the Invention] By the way, recently, the amusement game machine and computer terminal machine using a virtual reality (virtual reality) have appeared. Also in these game machines or a terminal, the image normal position with the sense of reality according to a screen is beginning to be required. For example, in a game machine, a motion of the flight sound which matched the motion of the airplane on a screen is beginning to be needed. In this case, the sound (music) which carried out migration processing of an image according to that motion beforehand when the course in which an airplane flew was decided is put in, and a game machine side is sufficient if that sound (music) is reproduced simply.
[0004] However, the courses (location) in which an airplane flies will differ according to actuation of an operator, and it will be necessary in a game machine (terminal) to carry out migration processing of the image which suited actuation on real time according to actuation, and to reproduce it. This point differs from the image normal position processing for records mentioned above sharply. For this reason, with the conventional equipment mentioned above, although the image stereotaxic instrument is needed for each game machine, since it is necessary to carry out FFT conversion of the signal from a sound source,

to process on a frequency shaft, to carry out reverse FFT conversion again, and to reproduce, a circuit scale tends to become large. Moreover, since it was the image normal position based on the data on a frequency shaft (transfer characteristics of the level difference depending on frequency, and phase contrast), approximation of HRTF (head transfer function) could not carry out correctly, and was not able to make the transfer characteristics hold with conventional equipment about all the required image normal position locations (360 a part for whenever).
[0005] namely, like "interactive video game equipment" given in JP,4-242684,A Only the transfer characteristics (coefficient) for carrying out the image normal position are prepared in the 3:00 direction and the 9:00 direction (it is the location direction of 90 degrees to the right and left from a transverse plane). Panpot processing was carried out [sound / the playback sound in a transverse-plane location, and / in the 3:00 direction (or the direction of 9:00) / normal position playback] substantially, and the image normal position was carried out (that is, both mixing rate was changed and the mid-position was made to orientate). However, it was difficult for the wide range space which crosses the range of 180 degrees in such simple processing to carry out the image normal position (to especially, back), and the feeling of the image normal position was also ambiguous.
[0006] Then, while this invention was made in view of this conventional above-mentioned trouble and a circuit scale is excellent in [it is small and] cost, it is possible to make the wide range space exceeding the range of 180 degrees orientate, and image static-control equipment excellent in a feeling of the image normal position is offered. The signal from a sound source is processed on a time-axis by the convolver of a pair, it is in the point constituted so that an image might be made to orientate, a circuit scale becomes very small by this, and the feature can be carried [1st] in a noncommercial or business-use game machine etc. Furthermore, approximation processing of the HRTF was carried out correctly, without being in the point which constituted the transfer characteristics for the image normal position (coefficient of a convolver) so that image processing might finally be carried out as data of IR on a time-axis (impulse response), and this spoiling a feeling of the image normal position to the 2nd, and the length of the coefficient of a convolver was shortened. It is having the coefficient of the convolver to which length's became [3rd] short as transfer characteristics of all (360 degrees' is covered) image normal position locations, carrying out a supply setup of the coefficient at a convolver according to the specified image normal position location, and having been made to carry out image normal position processing.
[0007]
[Means for Solving the Problem] In order that this invention may solve the above-mentioned technical problem, as shown in drawing 1 , from a transducer (loudspeakers sp1 and sp2) of a pair estranged and arranged A signal processed by convolver (convolution data-processing circuit where a coefficient consists of a cancellation filter which are cfLx and cfRx) of a pair to which the same sound source (X) was supplied is reproduced. It is image static-control equipment which a location (x) of arbitration where transducers of said pair differ is made to sense that an image is orientating at a listener (M). The convolvers 1 and 2 of a pair which collapses and carries out data processing of the signal from the same sound source according to a set-up coefficient, Convergence processing is carried out at predetermined length based on a head transfer function measured in each image normal position location. And a storage means 3 to hold a coefficient group for cancellation filters (cfLx, cfRx) which scaling processing was carried out at predetermined level, and was computed as an impulse response (coefficient ROM), Image static-control equipment characterized by consisting of a coefficient supply means (control means) 4 to supply a coefficient corresponding to a specified image normal position location to a convolver of said pair from said storage means is offered.
[0008]
[Function] According to the above image static-control equipments, a supply setup of the coefficient corresponding to the specified image normal position location is carried out at the convolvers 1 and 2 of a pair. According to the set-up coefficient, it collapses on a time-axis by the convolver of a pair, data processing is made, and the signal from a sound source (X) is reproduced from the transducer (loudspeakers sp1 and sp2) of the pair estranged and arranged. The cross talk to both ears is canceled,

the sound reproduced from the transducer of a pair carries out the image normal position, as a sound source is in the location (x) of desired arbitration, and it is heard by Listener (for example, game operator) M.

[0009]

[Example] One example of the image static-control equipment which becomes this invention is explained with a drawing below. First, the basic principle of the method of an image static control is explained. This is the technology of using the transducer (a loudspeaker being hereafter explained as an example) of the pair estranged and arranged, and making the location of the arbitration of space orientating an image.

[0010] Drawing 6 is principle drawing of the image normal position. sp1 and sp2 are loudspeakers arranged at a listening person's (a listener may be called in an example) front right and left, and they set [the head transfer characteristics (impulse response) from a loudspeaker sp1 to a listener left ear] h1R and the head transfer characteristics from a loudspeaker sp2 to a left right ear to h2L and h2R for h1L and the head transfer characteristics to a right ear. Moreover, the head transfer characteristics to a listening person left right ear when the actual loudspeaker has been arranged in the target normal position location x are set to pLx and pRx. Each transfer characteristics arrange a microphone to sound space in a loudspeaker and both the ears location of a dummy head (or ****), actually measure it, and perform suitable wave processing etc. here.

[0011] Next, it considers reproducing the signal acquired by signal converters cfLx and cfRx (transfer characteristics by a convolver etc.) through the sound source (source) X to make it orientate by loudspeakers sp1 and sp2, respectively. If the signal acquired by the listening person left right ear at this time is set to eL and eR eL=h1 L-cfLx-X+h2 L-cfRx-X (Formula 1) eR=h1 R-cfLx-X+h2 R-cfRx-X (**) When a sound source X is reproduced from the target normal position location and the signal acquired by the listening person left right ear is set to dL and dR, on the other hand, it is. dL=pLx-X (formula 2) dR=pRx-X (**) [0012] Here, if the signal acquired by the listening person left right ear by playback of loudspeakers sp1 and sp2 is in agreement with the signal when reproducing a sound source from the purpose location, a listening person will recognize an image that a loudspeaker exists in the purpose location. X is eliminated from this condition eL=dL, eR=dR, (a formula 1), and (a formula 2). h1 L-cfLx+h2 L-cfRx=pLx (Formula 3) h1 R-cfLx+h2 R-cfRx=pRx (**) (formula 3) from -- if cfLx and cfRx are calculated cfLx=(h2 R-pLx-h2 L-pRx)/H (formula 4a) cfRx=(-h1 R-pLx+h1 L-pRx)/H (**) It corrects. H=h1L-h2R-h2L-h1R (formula 4b) [0013] Therefore, if a signal to make it orientating by a convolver (convolution data-processing circuit) etc. using the transfer characteristics cfLx and cfRx computed by (Formula 4a) and (Formula 4b) is processed, the target location x can be made to orientate an image. Various idea **** should just realize the implementation method of a concrete signal converter, using DSP (Digital Signal Processor) as an unsymmetrical FIR (Finite Impulse Response) mold digital filter (convolver). In addition, the last transfer characteristics in the case of using by the FIR mold digital filter are a time response function. That is, as a coefficient for one FIR filtering to realize that for which it asked by (Formula 4a) and (Formula 4b) as transfer characteristics cfLx and cfRx in the required normal position location x, the coefficient of cfLx and cfRx is created beforehand and it prepares as data of ROM. The coefficient of a required image normal position location is transmitted to an FIR digital filter from ROM, and if data processing of the signal from a sound source is collapsed and carried out and it reproduces from the loudspeaker of a pair, an image will orientate in the location of desired arbitration.

[0014] the image static-control equipment based on the above principles -- calculation (step **-**) of the transfer characteristics (coefficients cfLx and cfRx) to kick is explained in full detail with reference to drawing 7 - drawing 9 . ** Measurement drawing 7 of a head transfer function (HRTF is called below Head Related Transfer Function;) shows the gaging system of HRTF. The pair microphones ML and MR are installed in both the ears of a dummy head (or ****) DM, the measurement sound from Loudspeaker SP is received, and the source sounds (reference data) refL and refR and the measured sounds (measurement data) L and R are recorded synchronizing with the sound recording machine DAT. As a source sound XH, an impulse sound, white noise, other noises, etc. can be used. The location of the

above-mentioned loudspeaker SP is installed in two or more angles theta (as shown in drawing 8 , it is a 12-point head every 30 degrees) in the space which fixed the transverse plane as 0 times (degree), and only predetermined time amount records it continuously, respectively.
[0015] ** Process the source sounds (reference data) refL and refR and the measured sounds (measurement data) L and R of the impulse response (IR is called below Impulse Response;) of HRTF which were synchronously recorded by the measurement which carried out the calculation above on a workstation (not shown). When the frequency response of HRTF [in / for the frequency response of X (S) and a measured sound (measurement data) / in the frequency response of a source sound (reference data) / Y (S) and a measuring point] is set to IR (S), there is input / output relation shown in (a formula 5).
Y(S) =IR(S) and X (S) (formula 5) therefore, the frequency response of HRTF -- IR (S) IR(S) =Y(S) / X (S) (formula 6) it is .
[0016] Therefore, it starts by the aperture which carried out the time amount synchronization of the data for which it asked by the aforementioned ** as the frequency response X of a reference (S), and frequency-response [of measurement data] Y (S), and after finite carries out the fourier expansion into series by FFT conversion, respectively and calculating as discrete frequency, the frequency response IR of HRTF (S) is calculated by the well-known count method by (the formula 6). In this case, in order to raise the precision of IR (S) (improvement in an SN ratio), IR (S) is calculated to hundreds of different apertures in time, respectively, and they are equalized. And reverse FFT conversion of the frequency response IR of calculated HRTF (S) is carried out, and it considers as the time-axis response (impulse response) (the 1st IR) IR of HRTF.
[0017] ** plastic surgery processing of IR (impulse response) -- here, operate orthopedically IR calculated by the aforementioned **. First, for example by FFT conversion, the 1st calculated IR is developed on the discrete frequency covering audio spectrum, and an unnecessary band (although a big DIP arises in a high region, this is an unnecessary thing which seldom influences the image normal position) is removed by BPF (band pass filter). Thus, since the unnecessary peak and unnecessary DIP on a frequency shaft are removed and an unnecessary coefficient stops arising in a cancellation filter when it band-limits, convergency becomes good and can shorten a coefficient. And reverse FFT conversion of the band-limited IR (S) is carried out, IR (impulse response) is started on a time-axis, an aperture (for example, aperture of a cosine function) is hung, and window processing is carried out (set to the 2nd IR). By carrying out window processing, the effective length of IR becomes less long, the convergency of a cancellation filter improves and deterioration of tone quality ceases to arise.
[0018] ** The cancellation filters cfLx and cfRx which are the calculation convolvers (collapsing integrating circuit) of the cancellation filters cfLx and cfRx in each image normal position location it was mentioned above and (formula 4a) (formula 4b) shown -- as -- cfLx=(h2 R-pLx-h2 L-pRx)/H (formula 4a) cfRx=(-h1 R-pLx+h1 L-pRx)/H (**) However, H=h1L-h2R-h2L-h1R (formula 4b) it is .
[0019] Here, the 2nd IR (impulse response) which was calculated by the aforementioned ** - ** and by which plastic surgery processing of each angle theta of every was carried out is substituted as head transfer characteristics pLx and pRx when the actual loudspeaker has been arranged in head transfer-characteristics h1L by the loudspeakers sp1 and sp2 arranged, h1R, h2L, h2R, and the normal position location x made into the purpose. If head transfer-characteristics h1L and h1R correspond to the location of the L channel loudspeaker of drawing 9 and are installed in the left by 30 degrees (theta= 330 degrees) from a transverse plane, IR of theta= 330 degrees is used for them. If head transfer-characteristics h2R and h2L correspond to the location of the R channel loudspeaker of this drawing and are installed in the right by 30 degrees (theta= 30 degrees) from a transverse plane, IR of theta= 30 degrees is used for them (that is, the thing near the system at the time of actual image playback (for example, shown in drawing 1) is chosen).
[0020] and as head transfer characteristics pLx and pRx By substituting IR in every 30 degrees in the wide range space (whole space) which exceeds it from the transverse plane which is the target sound source normal position location not to mention the range of 180 degrees of 90 right and left The cancellation filter cfLx and cfRx group of cfLx of the whole space corresponding to it and cfRx, i.e., 12

sets per 30 degrees, are called for (the location of 240 degrees is made into the example in drawing 9). Finally the cancellation filter cfLx and a cfRx group are called for as IR (impulse response) which is the response on a time-axis. moreover -- for shortening the coefficient of the cancellation filters cfLx and cfRx -- each -- it is required to shorten head transfer-characteristics h1L, h1R, h2L, pRx and pLx, and h2R, respectively. for this reason, the aforementioned ** - ** explained -- as -- various kinds of convergence processings, such as window processing and plastic surgery processing, -- carrying out -- each -- head transfer-characteristics h1L, h1R, h2L, pRx and pLx, and h2R are shortened. In addition, FFT conversion of the coefficients cfLx and cfRx of a cancellation filter is carried out, in quest of a frequency response, this may be moving-average-ized by fixed width of face, reverse FFT conversion of it may be carried out, and the time response of a final cancellation filter may be obtained. Thus, by moving-average-izing, an unnecessary peak and an unnecessary DIP can be removed, convergence of the time response which should be realized is brought forward, and the scale of a cancellation filter can be made small.

[0021] ** When the scaling of a cancellation filter and the spectrum distribution of a sound source (source sound) by which image processing is actually carried out by the convolver (cancellation filter) are found statistically, it has the thing distributed like a pink noise, or the thing which falls gently-sloping in a high region. Anyway, since it differs from a single sound, a sound source is overflowed when convolution data processing (integral) is performed, and has risk of distortion occurring. Then, in order to prevent overflow, when the thing of the greatest gain (for example, square sum of each sampled value of the cancellation filters cfLx and cfRx) in the coefficient of the cancellation filters cfLx and cfRx is found and the coefficient and the white noise of 0db are collapsed, the scaling of the total coefficient is carried out so that overflow may not arise. Furthermore, by the window aperture (cosine aperture), in accordance with the number of the coefficients of an actual convolver, window processing is carried out and effective length of a coefficient is shortened so that both ends may be set to 0. Thus, scaling processing is carried out and data constellation (at this example, it is coefficient group of 12 sets of convolvers in which the image normal position is possible every 30 degrees) cfLx and cfRx which are finally supplied to a convolver as a coefficient can be found.

[0022] Next, the system configuration using the configuration of image static-control equipment and this which are the important section of this invention is explained in full detail with reference to drawing 1 - drawing 5 . This image static-control equipment is the coefficients cfLx and cfRx computed by the aforementioned ** - **, collapses and calculates the signal from a sound source, and is reproduced.

[0023] (Example 1) Drawing 1 shows the fundamental configuration of this image static-control equipment. The convolvers 1 and 2 of the pair which image static-control equipment collapses the signal from a sound source on a time-axis, and carries out data processing (convolution data-processing circuit, in addition example 2 reference), The coefficient ROM 3 the coefficient groups cfLx and cfRx of 12 sets of convolvers for every 30 degrees computed by the above mentioned ** - ** were remembered to be The profile configuration is carried out from the control means (coefficient supply means which consists of a CPU) 4 which transmits the coefficient of a desired normal position location to the convolvers 1 and 2 of said pair from a coefficient ROM 3 based on an image normal position instruction.

[0024] And this image static-control equipment collapses and carries out data processing of the signal from the same (common) sound source by the convolvers 1 and 2 of a pair, and the system configuration is carried out so that it may reproduce from the loudspeakers sp1 and sp2 of the pair estranged and arranged on the predetermined aperture square focusing on Listener M. The aperture angle of loudspeakers sp1 and sp2 is an aperture angle made into criteria at the time of coefficient calculation of a convolver, and has **** and the aperture angle of 60 degrees 30 degrees right and left in this example (refer to above mentioned drawing 9). Moreover, the digital signal from a sound source (for example, the synthesizer X for games) is constituted so that it is inputted into said convolvers 1 and 2 through a selector (sound source selection means) 5, and in the case of an analog signal digital conversion may be carried out and it may be inputted with A/D converter 6. The signal by which data processing was collapsed and carried out by convolvers 1 and 2 is made into an analog signal with D/A converters 7 and 8, is amplified with amplifier 9 and 10, and is reproduced from the loudspeakers sp1 and sp2 of said pair.

[0025] thus, in the constituted image static controlled system The image normal position instruction from Maine CPU, such as a game machine, (for example, it is said take out a flight sound from 120 left back (theta= 240 degrees)) According to selection of a sound source, and the instruction of the normal position location of an image, said control means 4 chooses the signal from a sound source X by the selector (sound source selection means) 5. Furthermore, the coefficients cfLx and cfRx corresponding to an image normal position location (when you want the location of 120 left back (theta= 240 degrees) to carry out the image normal position, it is the coefficient of theta= 240 degrees) are read from ROM3, and a supply setup is carried out at convolvers 1 and 2.

[0026] Convolvers 1 and 2 collapse and carry out data processing of the signal (flight sound) from the same sound source X on a time-axis according to the set-up coefficient (coefficient of theta= 240 degrees). The signal by which convolution data processing was carried out is reproduced from the loudspeakers sp1 and sp2 of the pair estranged and arranged. It is reproduced from the loudspeakers sp1 and sp2 of a pair, and the cross talk to both ears is canceled, a sound carries out the image normal position, as a sound source is in a desired location (120 left back), it is heard by Listener (for example, game operator) M, and is reproduced as a sound extremely filled to the sense of reality. moreover, in the case of game equipment, the coefficient of convolvers 1 and 2 corresponds to a motion of the airplane according to actuation of Operator M -- as -- the image normal position instruction from Maine CPU -- it is switched at any time. Moreover, when changed into a missile sound from a flight sound, the source sound from a sound source is changed into a missile sound from a flight sound by the selector 5. Thus, since the location of desired arbitration can be made to orientate the image of a desired class according to this image static-control equipment, if picture reproducer (for example, picture reproducer DL which arranged four sets of displays in the flabellate form) etc. is installed in a transverse plane and sound reproduction is carried out with a game screen, a screen and an image change according to actuation of Operator M, and an amusement game machine with very high presence can be constituted.

[0027] Moreover, the aperture angle (sp1-M-sp2 of drawing 1) of loudspeakers sp1 and sp2 is an aperture angle made into criteria at the time of coefficient calculation of a convolver, and made the example the case where it had **** and the aperture angle of 60 degrees 30 degrees right and left, in this example. In addition, you may make it correspond to the system configuration which has **** and the aperture angle of 30 degrees 15 degrees right and left, as shown in drawing 1 . In this case, it is good to constitute so that the coefficient ROM 3 may be made to memorize 12 sets of coefficient groups for aperture angle 30 degrees, and 12 sets of coefficient groups for aperture angle 60 degrees, the condition (system information) of a loudspeaker setup may be further inputted into a control means 4 and the coefficient group according to an actual regeneration system may be chosen. Furthermore, since it changes with Measuring conditions of HRTF, the coefficient of a convolver may be considered about this point. Since there is individual difference in the magnitude of ****, the magnitude of a dummy head (or ****) is changed, it asks for some kinds, and you may enable it to use it alternatively according to a listener at the time of HRTF measurement (for example, the object for adults with the large head and for [with the small head] children). It is good to constitute so that a listener's condition (system information) may be inputted into a control means 4 also in this case and the coefficient group according to an actual condition may be chosen automatically.

[0028] Then, other examples based on the above-mentioned example are explained. the following examples -- it is, and about the example 1 and the common component, the same sign is attached and the explanation is omitted. Furthermore, since the system configuration by the loudspeakers sp1 and sp2 of the pair centering on Listener M is the same as that of the above mentioned example 1, it omits, and only the important section is shown.

[0029] (Example 2) This example 2 is an example which is what enabled the transfer of a sound source (data) or a coefficient to RAM in image static-control equipment, and was suitable for the evaluation equipment of an image static control, or the equipment which carries out image processing by the optimal coefficient according to a system configuration from the exterior. In drawing 2 , 9 is RAM which memorizes the coefficient groups cfLx and cfRx of the convolver loaded from the outside through an interface 10. 11 is the input means which consisted of joint Stig etc., and in order that it may carry out the assignment input of a desired image normal position location and a desired sound source, it is a thing. Furthermore, through the interface 10, it is constituted by the sound source XV (for example, PCM tone generator which reproduces PCM sound data) so that the external input of the data for sound sources may be carried out. In addition, the coefficient group of said convolver, the data for sound sources, etc. are loaded from storage, such as an external computer and CD-ROM.

[0030] On the other hand, from the input means 11 (or minding an interface 10 external device), an image normal position location and a sound source to process with equipment are inputted into a control means 4, are memorized as a series of procedures, and are processed. A control means 4 reads the coefficient according to an image normal position location from RAM9, and sets it as convolvers 1 and 2 while it chooses a sound source according to the inputted procedure and supplies it to convolvers 1 and 2. In addition, the concrete example of a configuration of convolvers 1 and 2 is explained here. DSP (Digital Signal Processor) etc. realizes convolvers 1 and 2 as an unsymmetrical FIR (Finite Impulse Response) mold filter which collapsed in the interior and possesses RAM for operation coefficients. The coefficient supplied by the control means 4 is temporarily memorized by buffers 12 and 13, and is read to them by convolvers 1 and 2. With the signal from buffers 12 and 13, a control means 4 checks that the coefficient written in buffers 12 and 13 has changed into the condition that reading appearance was carried out by convolvers 1 and 2, and writes the following coefficient in buffers 12 and 13 one by one. A control means 4 can perform efficiently not only the provisioning process of a coefficient but other processings by minding buffers 12 and 13. In addition, when a momentary coefficient change is required, a convolver 1 and two RAM for operation coefficients in two may be prepared, and a bank change (package change) may be carried out, or two buffers 12 and 13 are formed and you may make it switch them for a long time [the coefficient of convolvers 1 and 2].

[0031] Thus, since the constituted image static-control equipment is constituted so that the coefficient groups cfLx and cfRx of a convolver may not be formed in ROM fixed but may be loaded to a coefficient RAM 9 from the exterior like an example 1, it can perform modification of the coefficient group of a convolver easily. Therefore, the coefficient of the convolver which inputted the coefficient groups cfLx and cfRx of the convolver computed by the aforementioned ** - **, was made to actually carry out the image normal position, and carried out measurement calculation can be evaluated easily. Furthermore, many coefficient groups which change with system configurations (the arrangement location of a loudspeaker, a listener's condition) are prepared for mass storages, such as a group and CD-ROM, the most suitable coefficient group can be loaded and the image normal position can be carried out. Moreover, modification of the coefficient by version up is also easy.

[0032] (Example 3) This example 3 is what was constituted so that a convolver might be supplied, after carrying out gain control of the signal from a sound source, and it aims at prevention of overflow of a processing signal, and control between the distance of an image. In drawing 3 , a sound source XM is a sound source for example, by the MIDI (Musical Instrument Didital Interface) signal, and sound source control data and image normal position data are supplied as MIDI data from the external device OM. In the external sound source XM, while sending out an acoustic signal based on the sound source control data to which it restored, MIDI data is sent out to a control means 4 as it is. A control means 4 recovers the source level based on image normal position data mentioned [which mentions later and image-normal-position-orders] later from MIDI data. Furthermore, between a sound source XM and convolvers 1 and 2, the gain control means (a gain-adjustment means, for example, an adjustable attenuator) 14 is infixed. A control means 4 controls and carries out the gain adjustment of the gain control means 14 according to a source level while setting up a coefficient like the above-mentioned example according to the image normal position instruction from a sound source XM. A gain adjustment can be adjusted to every convolvers 1 of a pair, and 2 (it corresponds to a loudspeaker on either side).

[0033] If a such configuration is carried out, level of the signal from a sound source is made low and convolvers 1 and 2 are supplied when the output level of the selected sound source is high, the overflow at the time of convolution data processing can be prevented, and deterioration of tone quality can be prevented. At this time, the value (for example, value according to the scaling coefficient at the time of

coefficient calculation) of the gain which was adapted for the level of a coefficient and level change is beforehand prepared for the coefficient ROM with the coefficient, and it may be made to carry out gain control at a precision based on it.
[0034] Moreover, it is also possible to carry out a gain adjustment with the gain control means 14, and to control between the distance of an image. Gain is enlarged to near to orientate an image, and gain is controlled in the distance small to orientate an image. If between the distance of the image normal position carries out a gain adjustment with the class of sound source, and the angular position of the image normal position as it is specified, presence can be made to increase from an image normal position instruction more. At this time, with the coefficient data of a convolver, a different gain value according to the angle of the image normal position is measured beforehand, and is prepared for the coefficient ROM, and the distance of the image normal position may be controlled with a sufficient precision using this. Furthermore, with the gain control means 14, a difference may be given to the level of the signal supplied to convolvers 1 and 2, and an image normal position location, a feeling of the normal position, the width of face of the normal position, etc. may be adjusted delicately.
[0035] (Example 4) This example is an example which prepared two or more sets (2 sets) of convolvers of a pair, and is an example for which it was [being / where he wants to switch the normal position location of an image in an instant / the case, and] suitable in coincidence to orientate two or more images in a different location. As shown in drawing 4 (A), with this image static-control equipment, the 1st convolver 1 and 2 and the 2nd convolver 16 and 17 are put side by side as a convolver of a pair. The processing output from the 1st convolver 1 and 2 and the 2nd convolver 16 and 17 interlocks by selectors 18 and 19, is switched, and it is constituted so that it may be reproduced from the loudspeaker (not shown) of a pair.
[0036] It is based on said the 1st convolvers 1 and 2 and said 2nd convolver 16 and 17 control means 4, the coefficient of a normal position location different, respectively according to an image normal position instruction is supplied to them, and the convolution operation output according to the coefficient is outputted to said selectors 18 and 19. And according to the timing of a change, a control means 4 controls selectors 18 and 19, and the 1st convolvers 1 and 2 and 2nd convolver 16 and 17 are switched in an instant. Thus, if constituted, even when the coefficient of convolvers 1 and 2 is long, an image normal position location can be changed in an instant.
[0037] moreover -- drawing 4 -- (-- B --) -- being shown -- as -- the -- one -- a convolver -- one -- two -- said -- the -- two -- a convolver -- 16 -- 17 -- differing -- two -- a kind -- a sound source -- X -- X -- ' -- supplying -- convolution -- an operation -- an output -- right and left -- respectively -- mixing -- a pair -- a loudspeaker (not shown) -- from -- reproducing -- as -- you may constitute . Thus, if constituted, coincidence can be made to orientate two images in a different location. In addition, after carrying out gain control of a sound source X and the signal from X', the 1st convolvers 1 and 2 and 2nd convolver 16 and 17 may be supplied, and change may be given to a feeling of the image normal position.
[0038] (Example 5) This example 5 prepares the auxiliary loudspeaker which adds the output from the convolvers 1 and 2 of a pair, and is reproduced, and clarifies the image normal position of a transverse-plane location. As shown in drawing 5 , the output of the convolvers 1 and 2 of a pair is added with the addition switch 20, and it constitutes from this image static-control equipment so that it may reproduce by the auxiliary loudspeaker sp3 which arranged this addition output among the loudspeakers sp1 and sp2 of - pair (Listener's M transverse-plane location). The addition output is supplied to the loudspeaker through the addition switch 20. ON/OFF of the switch 20 is carried out by the control means 4. Usually, it is set to OFF, for example, an image normal position location is set to ON at the time of a transverse-plane location or the location near a transverse plane, and the addition output of the convolvers 1 and 2 of a pair is reproduced from the auxiliary loudspeaker sp3.
[0039] Thus, since a regenerative signal will be outputted also from the auxiliary loudspeaker sp3 of a transverse-plane location when making a transverse-plane location or the location near a transverse plane orientate an image if constituted, there is no inside omission of a sound, the image normal position of a transverse-plane location becomes clear, and the range which senses the normal position also spreads. Moreover, contrary to the configuration of drawing 5 , the auxiliary loudspeaker sp3 may be

formed in the center of back, and the addition output of the convolvers 1 and 2 of a pair may be reproduced from the auxiliary loudspeaker sp3 by setting the addition switch 20 to ON at the time of a location with the image normal position location near a back mid gear or the center of back. In addition, it may replace with a switch 21, an attenuator may be prepared, and not only mere ON/OFF but the playback sound volume from the auxiliary loudspeaker sp3, the rate of addition, etc. may be controlled.

[0040] (Example 6) This example is an example constituted so that cross fade processing of the output from two convolvers might be carried out, and is the configuration of having been suitable for prevention of the noise which is easy to generate at the case where a discrete image normal position location is changed continuously, and the time of the change of a coefficient while it constitutes each convolver which constitutes the convolver of a left Uichi pair from two pieces. As shown in drawing 10 , with this image static-control equipment, 2 sets, the 1st convolver 24R and 24L and the 2nd convolver 25R and 25L, are put side by side as a convolver of a pair. That is, as compared with the convolvers 1 and 2 of the pair shown in the 1st example (drawing 1), the convolver 1 for left (L) consists of two convolvers 24L and 25L, and the convolver 2 for right (R) consists of two convolvers 24R and 25R.

[0041] It connects with the same sound source X so that 2 sets of coefficients from which an image normal position location differs may be written in and reefing data processing may be carried out to the 1st convolver 24R and 24L and the 2nd convolver 25R and 25L. Furthermore, the cross fade means for output L consists of faders (adjustable attenuator) 21L and 22L and addition means 23L, and the cross fade means for output R consists of faders (adjustable attenuator) 21R and 22R and addition means 23R. And the processing output from Convolvers 24R and 25R is inputted into Faders (adjustable attenuator) 21R and 22R, and the processing output from Convolvers 24L and 25L is inputted into Faders (adjustable attenuator) 21L and 22L. And cross fade processing of the processing output from Convolvers 24R and 25R is carried out by Faders 21R and 22R and addition means 23R, and cross fade processing of the processing output from Convolvers 24L and 25L is carried out by Faders 21L and 22L and addition means 23L. The output (L, R) of the right and left by which cross fade processing was finally carried out in this way is reproduced from the loudspeaker (not shown) of a pair.

[0042] In the image static-control equipment constituted as mentioned above with said 1st convolver 24R and 24L at the time of modification of an image normal position location (at the time of the modification change of a coefficient namely, --) the coefficient (coefficient before and behind a change) of a normal position location different, respectively which followed the image normal position instruction at the 2nd convolver 25R and 25L -- a control means 4 -- therefore it was supplied and responded to the coefficient -- it collapses and an operation output is outputted to said faders 21R and 22R and Faders 21L and 22L. Furthermore, by the cross fade control signal from a control means 4, cross fade processing is carried out and the reefing operation output before and behind a change is reproduced.

[0043] It is as follows when this point is explained in full detail. Drawing 11 is drawing explaining the timing of cross fade processing. For example, let the case where it shifts to the condition of carrying out image normal position processing be an example in a 60 current location at the location of 90 degrees from the condition which is carrying out image normal position processing. The coefficient for 60 degrees is supplied, one convolver 24R and 24L, for example, the 1st convolver, is working, and its 2nd convolver 25R and 25L which is convolvers of another side is un-working. In this condition, if a control means 4 has the change instruction of the image normal position location to a location 90 degrees from the location of 60 degrees (refer to this drawing (A)), a control means 4 will supply the coefficient for 90 degrees to the 2nd convolver 25R and 25L (refer to this drawing (B)). Furthermore, a cross fade control signal is outputted to Faders 21R and 22R and Faders 21L and 22L from a control means 4 (refer to this drawing (C)).

[0044] And it is switched, Faders 21R and 21L and Faders 22R and 22L operating, as shown in this drawing (D) and (E), fade-out of the output of the 1st convolver 24R and 24L being carried out according to a cross fade control signal, and fade-in of the output to the 2nd convolver 25R and 25L being carried out, and carrying out cross fade from the 1st convolver 24R and 24L to the 2nd convolver

25R and 25L. Without a change noise occurring, if it switches over the time amount for dozens of ms, carrying out cross fade, a coefficient is switched and an image normal position location can be changed. Moreover, the time amount of cross fade sends out optimal different time amount for every actuation, and you may make it control it with a cross fade control signal. If it does in this way, between discrete image normal position locations (for example, the location of 60 degrees and a 90-degree location) can also be changed continuously.

[0045] In each above examples 1-5, a head telephone can also be used instead of the loudspeakers sp1 and sp2 of - pair as a transducer for playback. In this case, since the Measuring conditions of HRTF differ, a coefficient is prepared independently and it switches according to recovery status.

[0046] In addition, the configuration which reproduces the signal processed by the convolver of the pair to which the same sound source was supplied from the transducer (loudspeaker) of the pair estranged and arranged explained in each example shows the minimum configuration for acquiring the effect of the image normal position. Therefore, like examples 4 and 5, if necessity is accepted, of course, the additional configuration of a pair, i.e., two or more transducers, and the convolver may be carried out, and when the coefficient of a convolver is still longer, a coefficient may be divided and you may constitute from two or more convolvers.

[0047] Moreover, as a coefficient group of a convolver, only the semicircle section (refer to drawing 8) to theta= 0 - 180 degrees may be prepared for a coefficient ROM, and using the dipleurogenesis of a coefficient, the remaining semicircle section may constitute so that a coefficient may be supplied to a convolver.

[0048] as the circuit which actually carries out image processing since the signal from a sound source is processed on a time-axis by the convolver of a pair and it was made to make an image orientate as explained in full detail above according to the image static-control equipment which becomes this invention -- the convolution data-processing circuit (convolver) on a time-axis -- a pair -- it only becomes required and a circuit scale becomes a very small cheap thing. That is, it is not necessary to carry out FFT conversion of the signal from a sound source, to process on a frequency shaft like the conventional method mentioned above, and to use the reproduced complicated circuit which carries out reverse FFT conversion again.

[0049] Moreover, since the coefficient of image normal position processing of said convolver was finally used as the data of IR on a time-axis (impulse response), the number of the coefficients of a convolver can be lessened and a circuit scale can be made small. That is, as compared with the case where it approximates as data as the level difference and phase contrast on a frequency shaft, a coefficient becomes short like conventional equipment, without being able to carry out approximation processing of the HRTF correctly and effectively, and spoiling a feeling of the image normal position by coefficient calculation processing mentioned above **-** In which it can set. Therefore, it can have a coefficient corresponding to many image normal position locations.

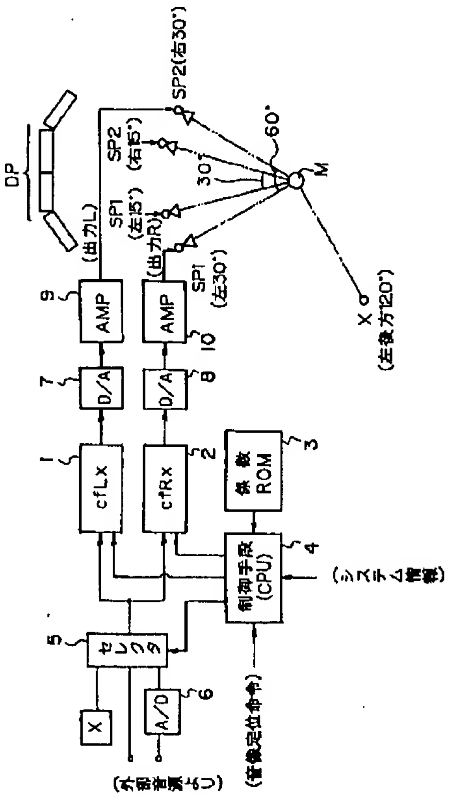
[0050] That is, since it had the coefficient of a convolver which length was pressed down and became short as transfer characteristics of each far-reaching image normal position location of 360 degrees, and a supply setup of the coefficient (transfer characteristics) is carried out at a convolver and it was made to carry out image normal position processing according to the specified image normal position location, the large area of 360 degrees can be made to orientate an image freely, and the feeling of the normal position is also clear. That is, it has only the transfer characteristics of a direction and the direction of 9 : 00 (it is the location direction of 90 degrees to the right and left from a transverse plane) at 3 : 00, and panpot processing carries out [sound / the playback sound in a transverse plane location, and / in the 3 : 00 direction (or the direction of 9 : 00) / normal position playback] substantially, and, unlike the simple false configuration which carries out the image normal position, neither a limit of a normal position location nor the

[0051] Moreover, since the location of desired arbitration can be made to orientate the image of a desired class, if a display etc. is installed in a transverse plane and sound reproduction is carried out with a game screen for example, a screen and an image change according to actuation and an amusement game machine with very high presence can consist of what established a sound source selection means

to have chosen the specified sound source from two or more sound sources, and to supply the convolver of a pair.
[0052] Moreover, it constitutes from a storage means by which a storage means to hold the coefficient group for cancellation filters can be written freely, and if it carries out as [transmit / from the exterior / to a storage means / a coefficient group], it is suitable for the evaluation equipment of an image static control, or the equipment processed by the optimal coefficient according to a system configuration.
[0053] Moreover, since the image static control of the optimal coefficient group according to the constituted system is chosen and carried out, a feeling of the image normal position is good what has a means to input the system information of the image static-control equipment by which a system configuration is carried out.
[0054] Moreover, gain control of the signal from a sound source is carried out, overflow of a processing signal can be prevented or between the distance of an image can be controlled by what established the gain-adjustment means.
[0055] Moreover, the normal position location of an image can be switched in an instant, or coincidence can be made to orientate the image from which plurality differs in a different location in what prepared two or more sets of convolvers of a pair.
[0056] Moreover, in what established an addition means to add the signal processed by the convolver of a pair, an addition output can be reproduced by the auxiliary loudspeaker and the image normal position of a specific location can be clarified.
[0057] Moreover, in what constitutes each convolver which constitutes the convolver of a left Uichi pair from two pieces, carries out cross fade processing of the output from two convolvers, and switched the coefficient, the noise which is easy to generate at the time of the change of a coefficient can be prevented, and a discrete image normal position location can also be changed continuously.
[0058] In addition, the faders 21L and 22L for cross fade as shown in drawing 10 etc. are not restricted to the configuration prepared in back, such as Convolvers 24L and 25L. For example, Faders 21L and 22L are formed before Convolvers 24L and 25L, and it constitutes and may be made to carry out cross fade processing so that the output of Convolvers 24L and 25L may be supplied to addition means 23L.
[0059]
[Effect of the Invention] Since the signal from a sound source is processed on a time-axis by the convolver of a pair and it was made to make an image orientate as explained in full detail above according to the image static-control equipment which becomes this invention, as a circuit which actually carries out image processing, the convolver (convolution data-processing circuit) on a time-axis is only needed, DSP can be used, and a circuit scale becomes a very small cheap thing. Furthermore, since the coefficient data of image normal position processing of said convolver was finally used as the data of IR on a time-axis (impulse response), approximation processing of the HRTF can be carried out correctly and effectively. Therefore, equipment can be equipped with the transfer characteristics of all image normal position locations (360 degrees), and image processing is carried out by the coefficient of the short convolver by which approximation processing was carried out by the optimal transfer characteristics supported theoretically and practically to every image normal position location. Therefore, whenever [360] can reach far and wide, an image can be made to orientate freely, and the feeling of the normal position is also clear.

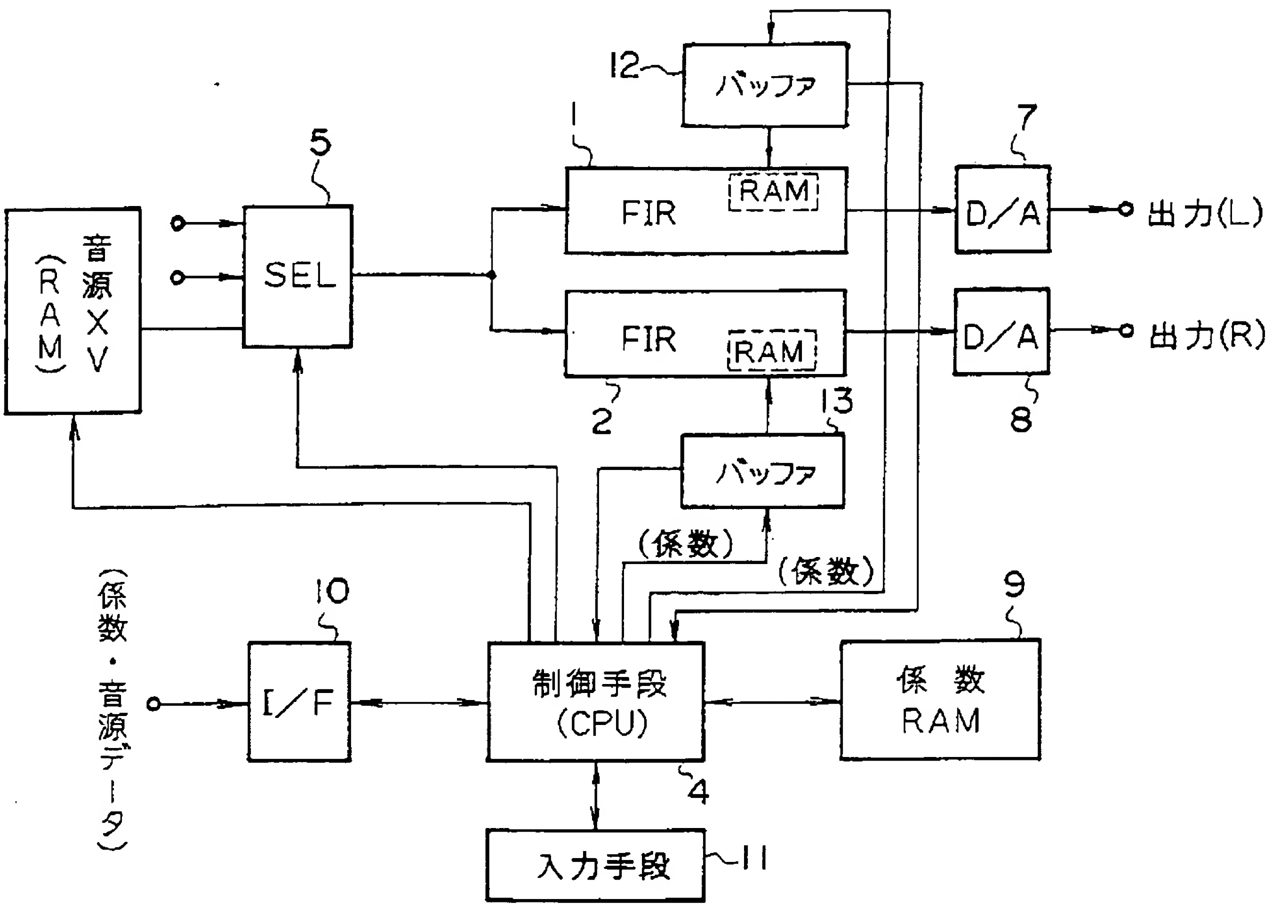
[Translation done.]

Drawing selection drawing 1


DP
SP2(右30°)
SP2 (右15°)
SP1 (左15°)
SP1 (左30°)
(出力L)
(出力R)
60°
30°
M
X (左後方120°)
9
AMP
10
7
D/A
8
1
cfLx
2
cfRx
3
係数 ROM
4
制御手段 (CPU)
(システム情報)
5
セレクタ
X
6
A/D
(外部音源より)
(音像定位命令)

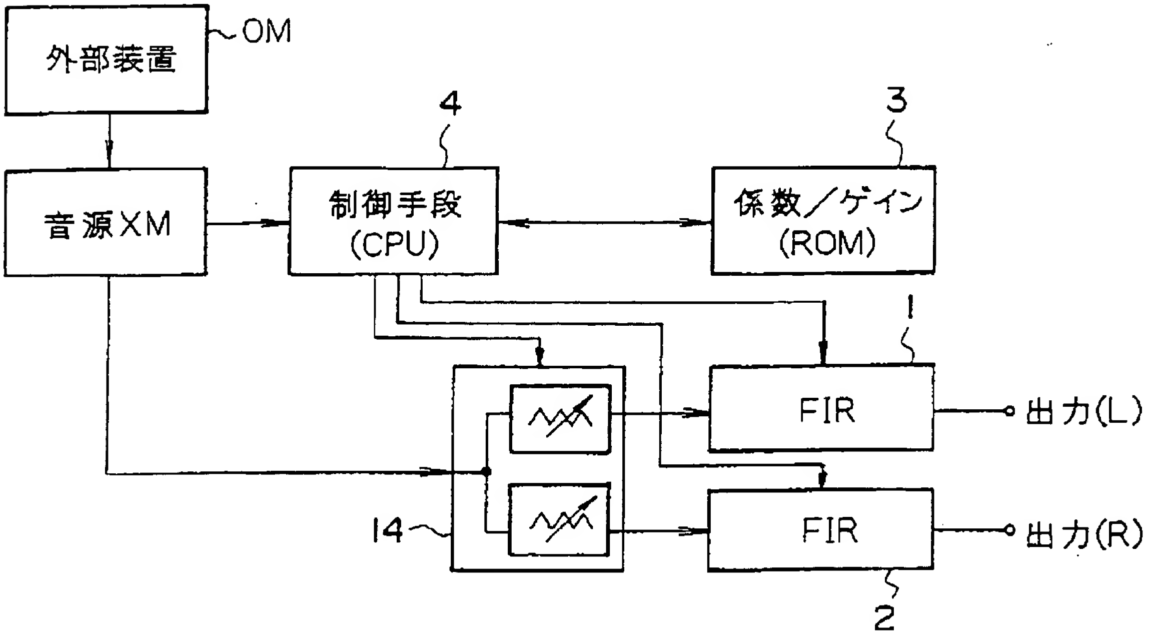
[Translation done.]

Drawing selection drawing 2


12
バッファ
1
FIR
RAM
7
D/A
出力(L)
5
SEL
音源XV
(RAM)
FIR
RAM
D/A
出力(R)
2
13
8
バッファ
(係数)
(係数)
10
9
(係数・音源データ)
I/F
制御手段
(CPU)
係数
RAM
4
入力手段
11

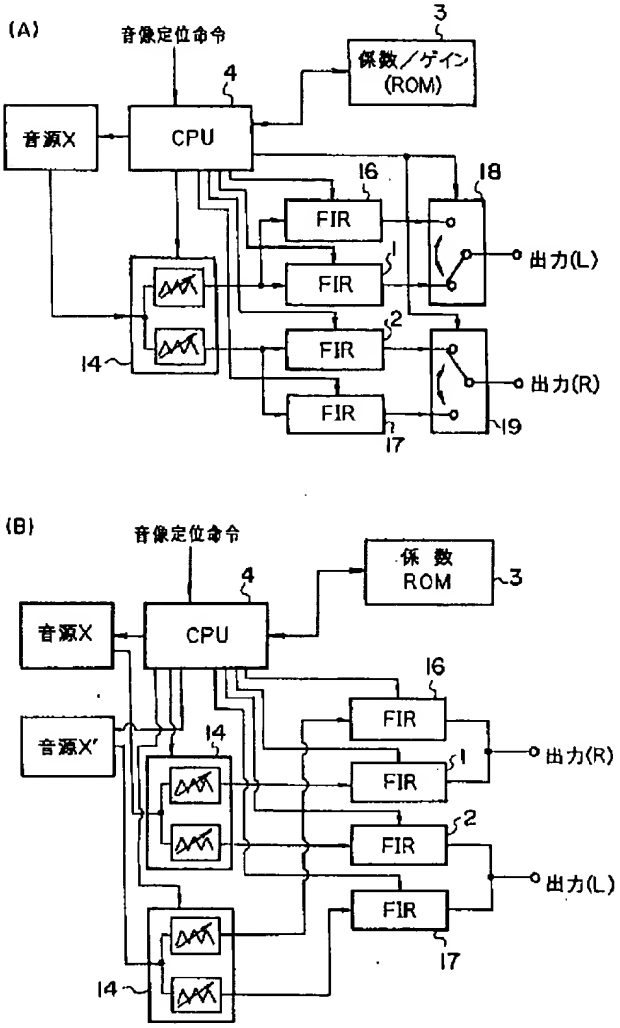
[Translation done.]

Drawing selection drawing 3


外部装置
OM
4
3
音源XM
制御手段
(CPU)
係数／ゲイン
(ROM)
1
FIR
出力(L)
14
FIR
出力(R)
2

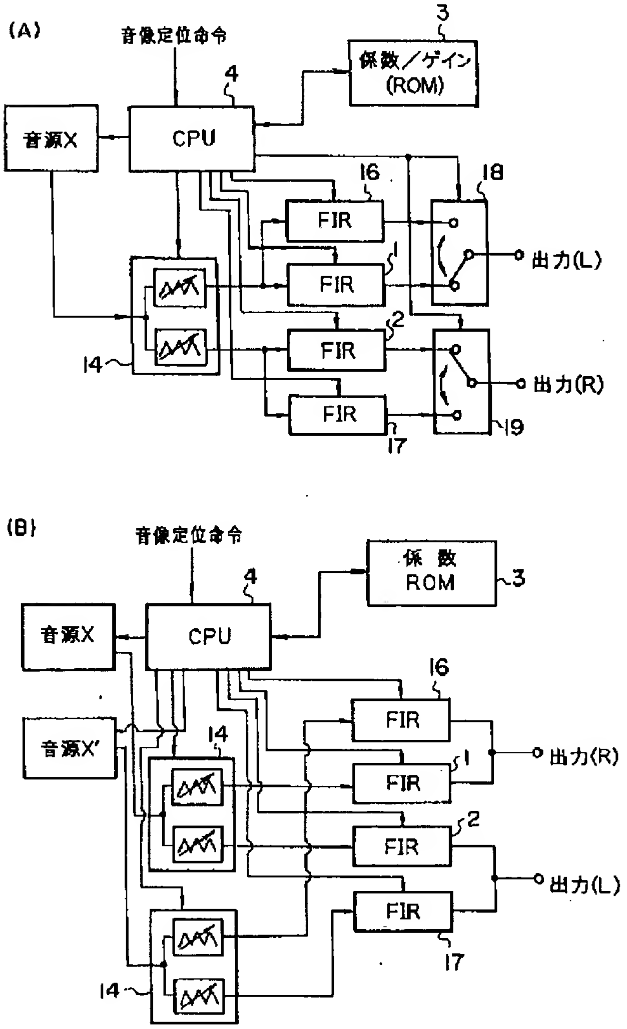
[Translation done.]

Drawing selection drawing 4


(A)
音像定位命令
3
係数／ゲイン (ROM)
4
音源X
CPU
16
18
FIR
FIR
1
出力(L)
2
FIR
出力(R)
14
FIR
17
19
(B)
音像定位命令
係数 ROM
3
4
音源X
CPU
16
音源X'
14
FIR
FIR
1
出力(R)
FIR
2
出力(L)
FIR
17
14

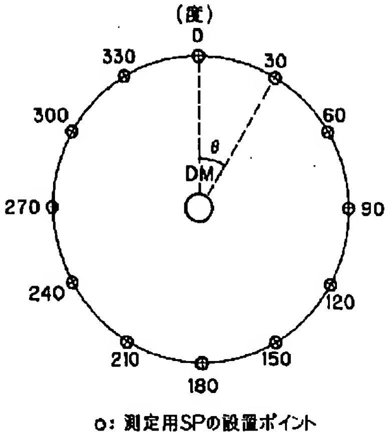
[Translation done.]

Drawing selection drawing 5


(A)
音像定位命令
3
係数／ゲイン
(ROM)
4
音源X
CPU
16
18
FIR
1
FIR
出力(L)
2
FIR
出力(R)
14
FIR
17
19
(B)
音像定位命令
係数
ROM
3
4
音源X
CPU
16
音源X'
14
FIR
1
FIR
出力(R)
2
FIR
出力(L)
FIR
17
14

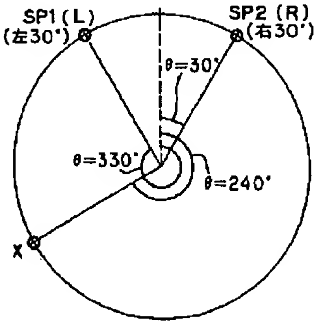
[Translation done.]

Drawing selection drawing 6


(度)
0
30
60
90
120
150
180
210
240
270
300
330
θ
DM
○: 測定用SPの設置ポイント

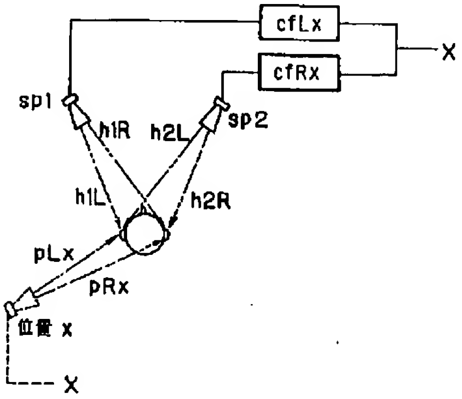
[Translation done.]

Drawing selection drawing 7


SP1 (L)
(左30°)
SP2 (R)
(右30°)
θ=30°
θ=330°
θ=240°
X

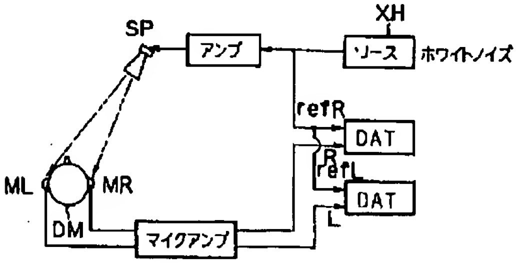
[Translation done.]

Drawing selection drawing 8


cfLx
cfRx
X
sp1
h1R
h2L
sp2
h1L
h2R
pLx
pRx
位置 x
X

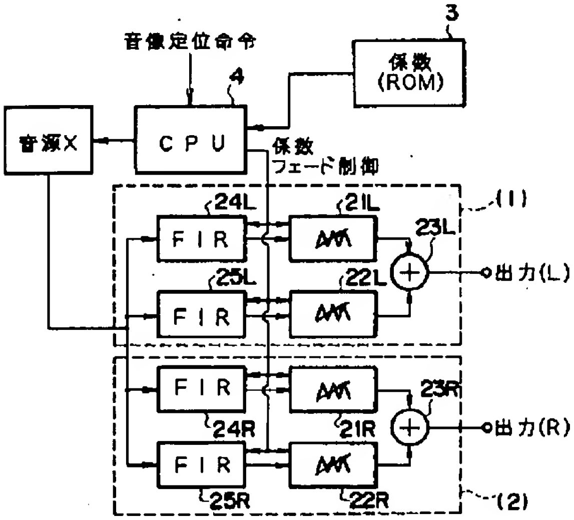
[Translation done.]

Drawing selection drawing 9


XH
SP
アンプ
ソース
ホワイトノイズ
refR
DAT
R
refL
DAT
L
ML
MR
DM
マイクアンプ

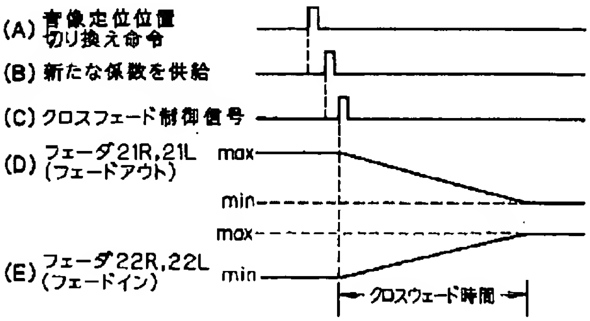
[Translation done.]

Drawing selection drawing 10


音像定位命令
3
係数
(ROM)
4
音源X
C P U
係数
フェード制御
24L
21L
(1)
F I R
23L
出力(L)
25L
22L
F I R
F I R
23R
出力(R)
24R
21R
F I R
25R
22R
(2)

[Translation done.]

Drawing selection drawing 11


(A) 音像定位位置切り換え命令
(B) 新たな係数を供給
(C) クロスフェード制御信号
(D) フェーダ21R,21L (フェードアウト)
max
min
max
(E) フェーダ22R,22L (フェードイン)
min
クロスウェード時間

[Translation done.]

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